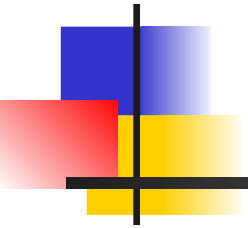
ANATOMY AND PHYSIOLOGY OF THE EAR



Main Components of the Hearing Mechanism:

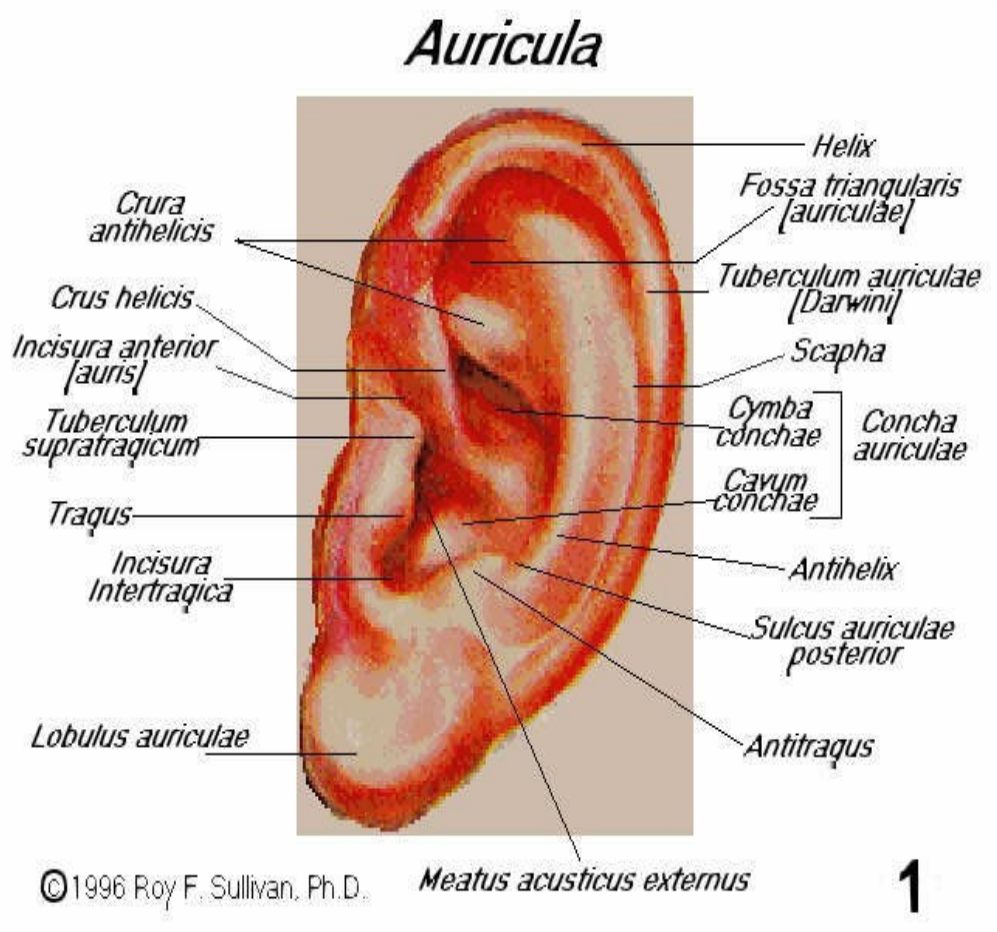
Divided into 4 parts (by function):

- **Outer Ear**
- **Middle Ear**
- **Inner Ear**
- **Central Auditory Nervous System**

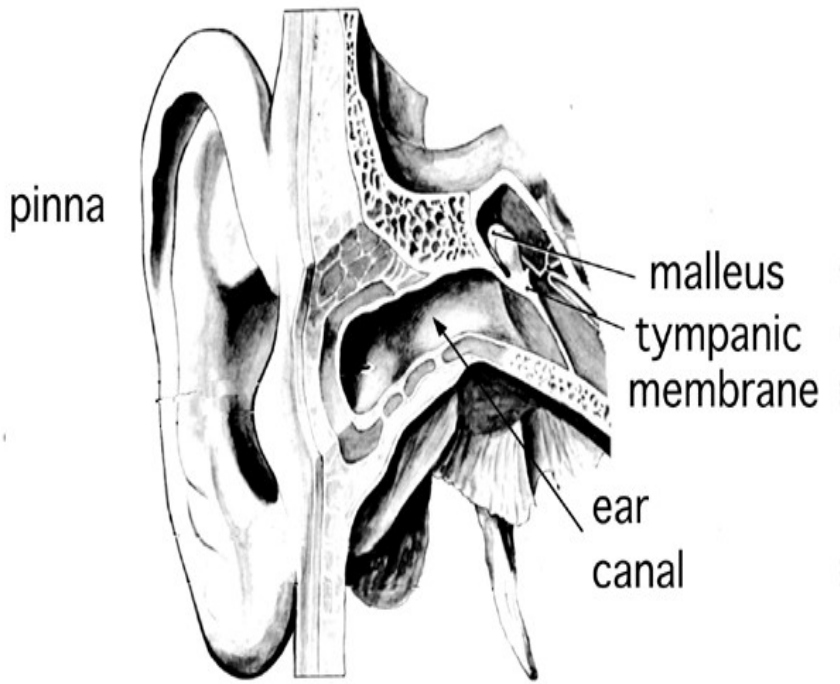
Structures of the Outer Ear

Auricle (Pinna)

- **Gathers sound waves**
- **Aids in localization**
- **Amplifies sound approx. 5-6 dB**



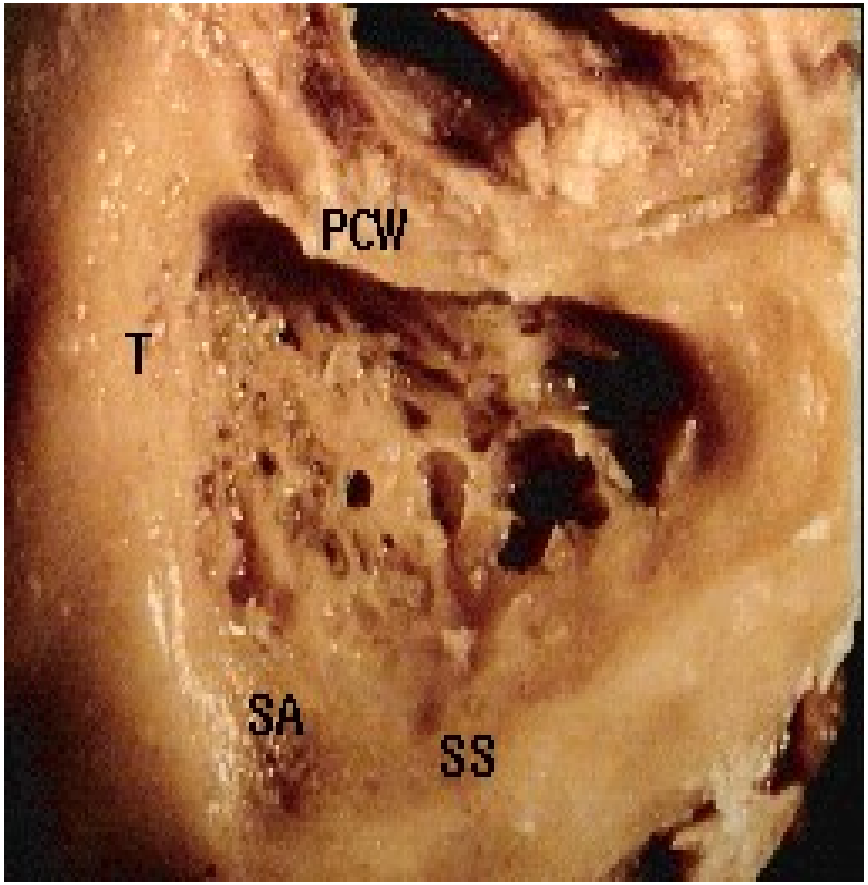
External Auditory Canal:



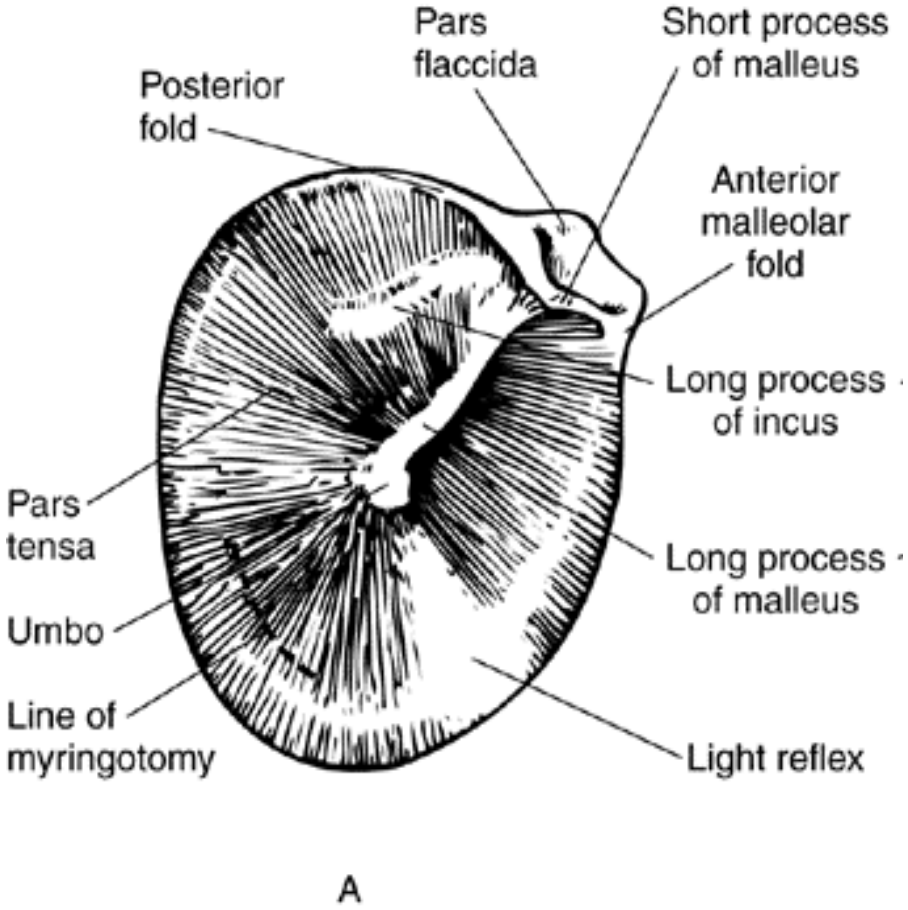
- Approx. 1 inch long
- “S” shaped
- Outer 1/3 surrounded by cartilage; inner 2/3 by mastoid bone
- Allows air to warm before reaching TM
- Isolates TM from physical damage
- Cerumen glands moisten/soften skin
- Presence of some cerumen is normal

Mastoid Process of Temporal Bone

- Bony ridge behind the auricle
- Hardest bone in body, protects cochlea and vestibular system
- Provides support to the external ear and posterior wall of the middle ear cavity
- Contains air cavities which can be reservoir for infection



Tympanic Membrane



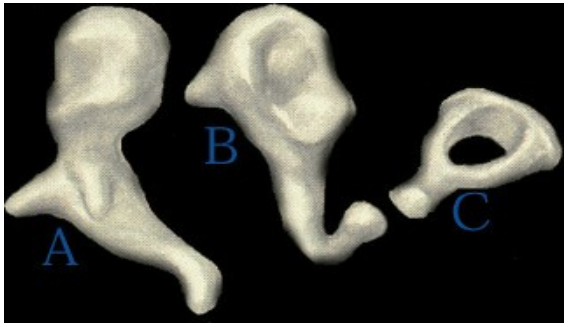
(From Merck Manual)

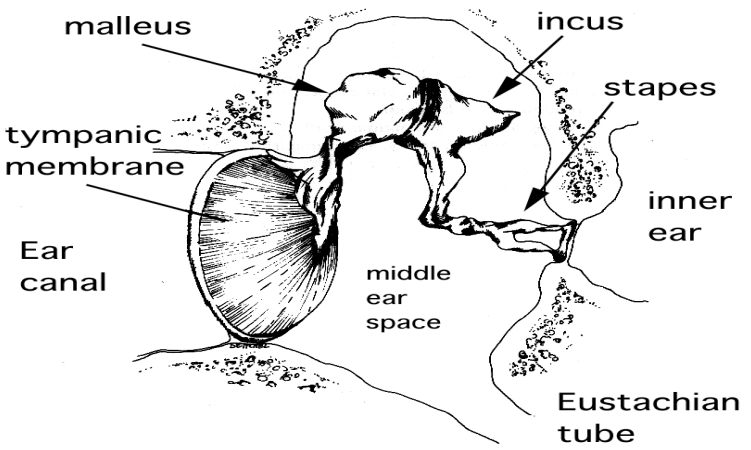
- **Thin membrane**
- **Forms boundary between outer and middle ear**
- **Vibrates in response to sound waves**
- **Changes acoustical energy into mechanical energy**

The Ossicles

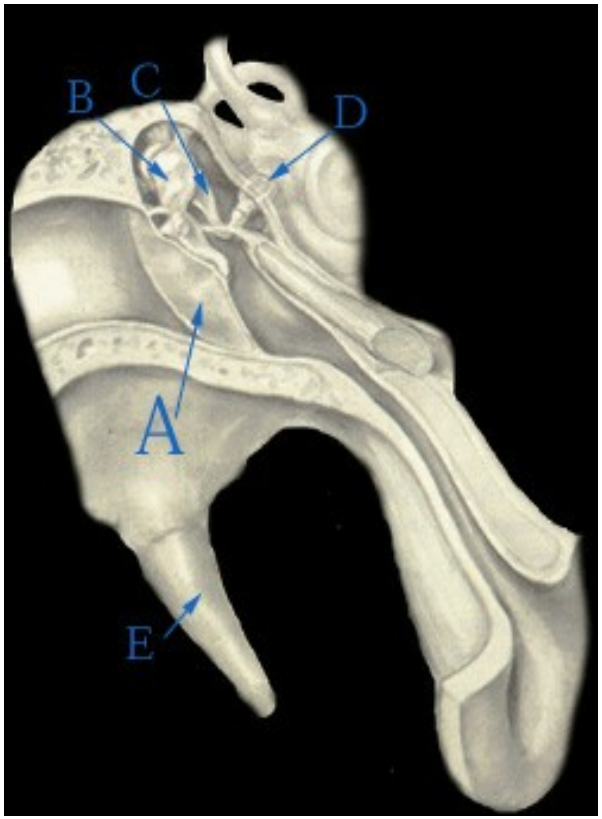
- Ossicular chain = malleus, incus & stapes
- Malleus
  - TM attaches at Umbo
- Incus
  - Connector function
- Stapes
  - Smallest bone in the body
  - Footplate inserts in oval window on medial wall

Focus/amplify vibration of TM to smaller area, enables vibration of cochlear fluids





Eustachian Tube (AKA: "The Equalizer")



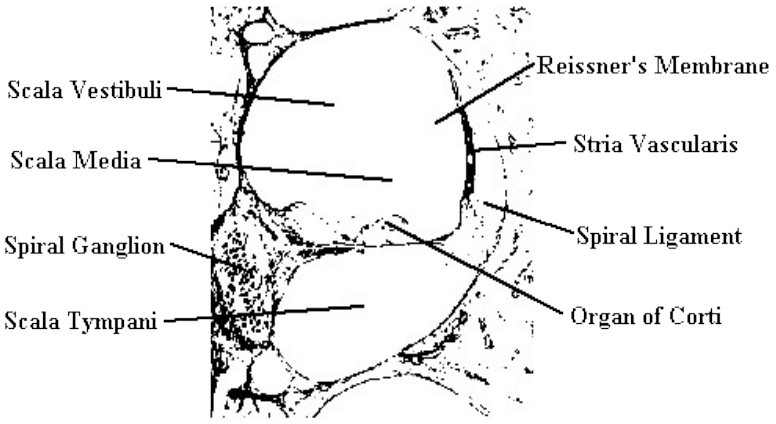
- **Mucous-lined, connects middle ear cavity to nasopharynx**
- **"Equalizes" air pressure in middle ear**
- **Normally closed, opens under certain conditions**
- **May allow a pathway for infection**
- **Children "grow out of" most middle ear problems as this tube lengthens and becomes more vertical**

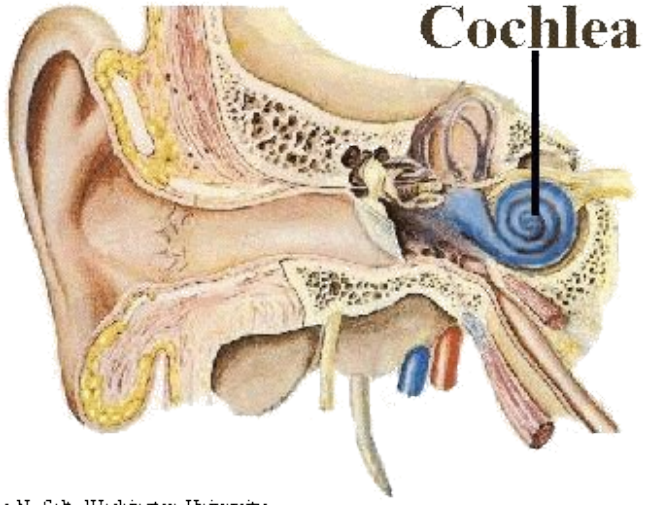
Stapedius Muscle

- Attaches to stapes
- Contracts in response to loud sounds; (the Acoustic Reflex)
- Changes stapes mode of vibration; makes it less efficient and reduce loudness perceived
- Built-in earplugs!
- Absent acoustic reflex could signal conductive loss or marked sensorineural loss

Structures of the Inner Ear: The Cochlea

- **Snail shaped cavity within mastoid bone**
- **2 ½ turns, 3 fluid-filled chambers**
- **Scala Media contains Organ of Corti Converts mechanical energy to electrical energy**

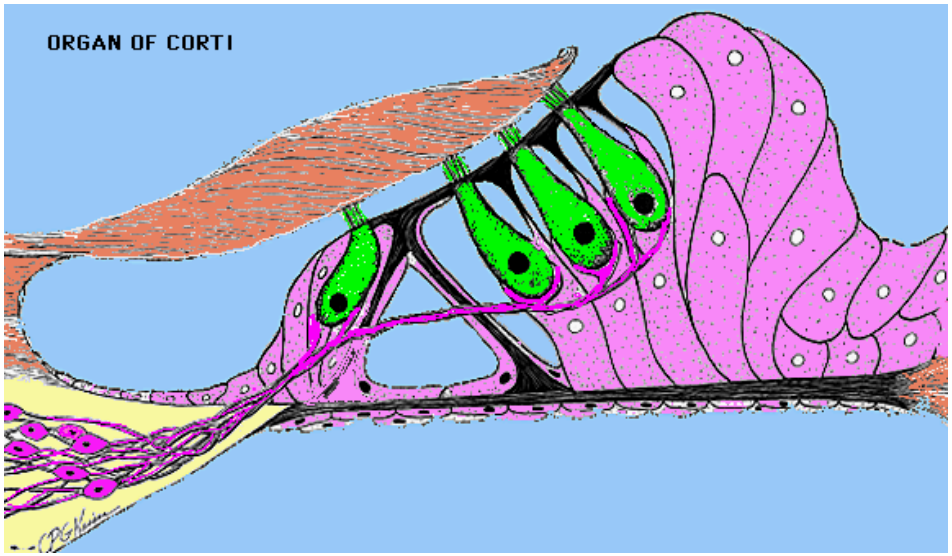


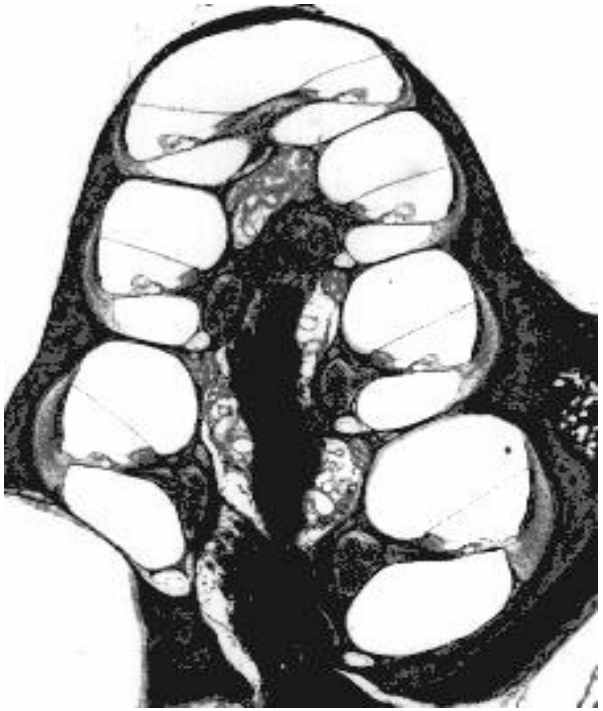


Alec N. Salt, Washington University

Organ Of Corti

- **The end organ of hearing**
  - **Contains stereocilia & receptor hair cells**
  - **3 rows OHC, 1 row IHC**
  - **Tectorial and Basilar Membranes**
  - **Cochlear fluids**

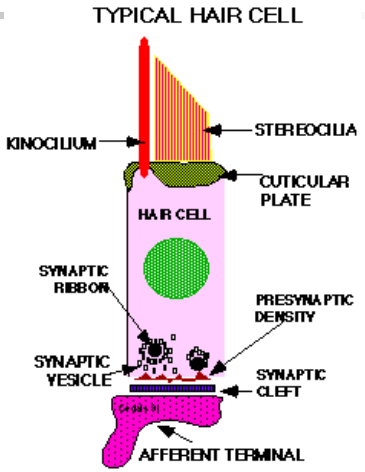


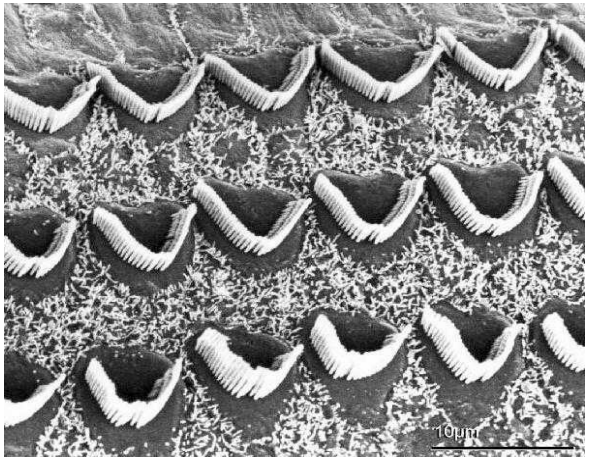


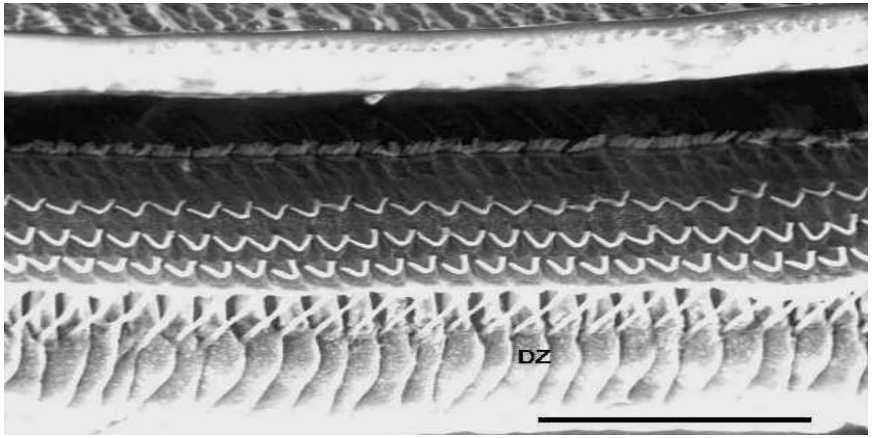
(From Augustana College, “Virtual Tour of the Ear”)

Hair Cells

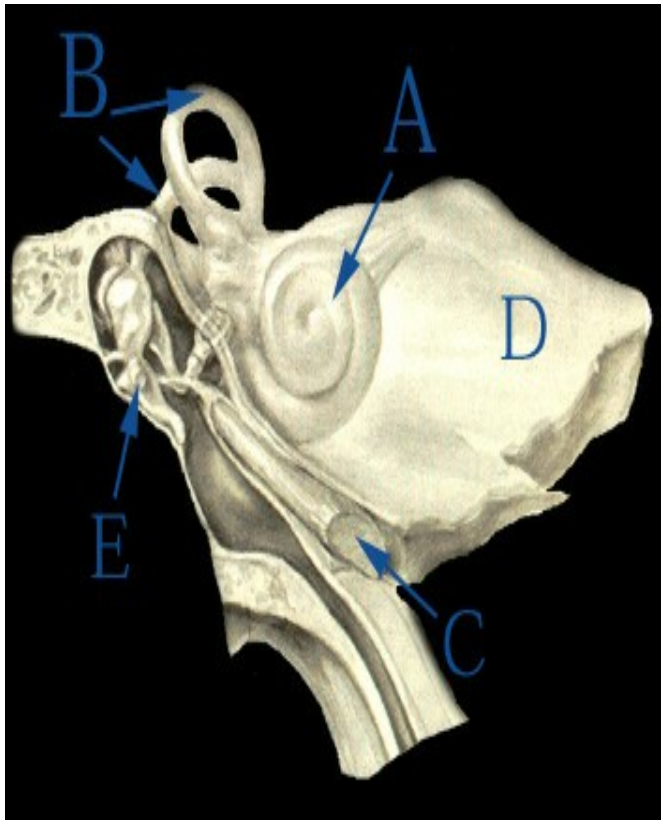
- **Frequency specific**
  - **High pitches= base of cochlea**
  - **Low pitches= apex of cochlea**
  - **Fluid movement causes deflection of nerve endings**
  - **Nerve impulses (electrical energy) are generated and sent to the brain**



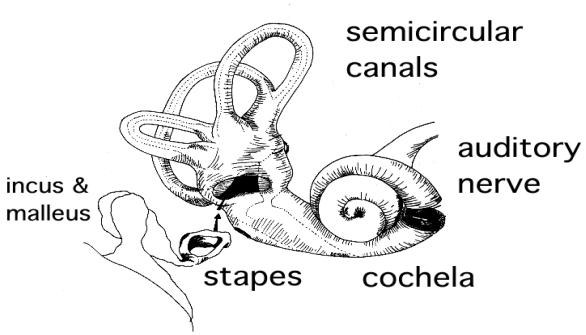




Vestibular System



- **Consists of three semi-circular canals**
- **Monitors the position of the head in space**
- **Controls balance**
- **Shares fluid with the cochlea**
- **Cochlea & Vestibular system comprise the inner ear**



Central Auditory System

- **VIIIth Cranial Nerve or “Auditory Nerve”**
  - **Bundle of nerve fibers (25-30K)**
  - **Travels from cochlea through internal auditory meatus to skull cavity and brain stem**
  - **Carry signals from cochlea to primary auditory cortex, with continuous processing along the way**
- **Auditory Cortex**
  - **Wernicke’s Area within Temporal Lobe of the brain**
  - **Sounds interpreted based on experience/association**

Summary: How Sound Travels Through The Ear

Acoustic energy*, in the form of sound waves, is channeled into the ear canal by the pinna. Sound waves hit the tympanic membrane and cause it to vibrate, like a drum, changing it into *mechanical energy*. The malleus, which is attached to the tympanic membrane, starts the ossicles into motion. The stapes moves in and out of the oval window of the cochlea creating a fluid motion, or *hydraulic energy*. The fluid movement causes membranes in the Organ of Corti to shear against the hair cells. This creates an *electrical signal

QUESTIONS?